INDOOR AIR QUALITY REASSESSMENT

Department of Revenue
Child Support Enforcement Division
239 Causeway Street
Boston, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
August 2002

Background/Introduction

In response to a request from Don Trudell, Department of Revenue (DOR), an indoor air quality reassessment was done at the Boston DOR, Child Support Enforcement Division (CSE) facility at 239 Causeway Street, Boston, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). On April 19, 2002, a visit was made to this building by Cory Holmes, Environmental Analyst in the Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Holmes was accompanied by Ed Carney, DOR Project Manager.

The building at 239 Causeway Street is a five-story brick building, originally built as a factory/warehouse in the late 1800's. The CSE moved into the second and third floors of the building in 1998. The second floor space currently consists of training rooms, filing rooms, a law library and a staff break room. The third floor is being used as office space.

Actions on Recommendations Previously Made by MDPH

BEHA staff had previously visited the building in September 2000 and issued a report that made recommendations to improve indoor air quality in various sections of the building (MDPH, 2000). A summary of actions taken on previous recommendations is included as Appendix I of this report.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor.

Results

The CSE has a maximum population of approximately 90-100 on a daily basis. The tests were taken under normal operating conditions. Test results appear in Tables 1-5. Air samples are listed in the tables by occupant last name or location that the air sample was taken as appears on the floor plan shown in Figure I.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were above 800 parts per million parts of air [ppm] in nineteen out of twenty-five areas sampled. These carbon dioxide levels indicate an inadequate air exchange in a number of areas sampled, however most of these areas were only slightly elevated above 800 ppm. The overall results indicate improved air exchange in the building as compared to the previous visit (see Tables 4-5).

Ventilation is provided by a heating, ventilation and air conditioning (HVAC) system. Fresh air is introduced by a rooftop-mounted air-handling unit (AHU), and distributed to occupied areas via ductwork located in the ceiling plenum throughout the second and third floors. Flexible ductwork attached to the main duct delivers air to work stations via ceiling mounted fresh air ducts. In an effort to facilitate airflow, heat pumps

are located above ceiling tiles throughout the second and third floors. Transfer air from the AHU is drawn directly into the heat pumps and delivered to work stations via ceiling-mounted air diffusers.

The ventilation system is controlled by thermostats. Thermostats have a fan switch, which can be set to either "auto" or "on". The left switch controls the heating/air-conditioning units according to temperature settings located at the top of the thermostat. The right switch controls the fan, which distributes fresh air to specific areas via heat pumps. At the time of the assessment, switches were set to the fan "on", which provides a continuous source of fresh air to the space.

Exhaust ventilation is provided by draw of air through metal/plastic grates into a ceiling plenum, which returns air to the AHUs. This system uses the entire above ceiling space to draw air back to the AHU via ductwork.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur,

leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix II.

Temperature measurements ranged from 69^{o} F to 73^{o} F, which were within or very close to the BEHA recommended comfort range in all areas surveyed. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in this building ranged from 38 to 43 percent, which was also within or very close to the BEHA recommended comfort range for all areas. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the DOR would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative

humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several areas had a number of plants. In some areas potting soil was observed on flat surfaces surrounding plants (see Picture 1). The plant in Picture 2 was sitting in standing water, which can become stagnant, providing a source of microbial growth and associated odors.

Water damaged ceiling tiles were observed in area 379, near the support beam and in the hallway outside of the women's restroom (see Picture 3). Water-damaged ceiling tiles can provide a source of microbial growth and should be replaced after a water leak is discovered.

A number of areas had water coolers, water fountains and small refrigerators installed over carpeting. Water spillage or overflow of cooler catch basins can result in the wetting of the carpet. Residue/build-up in the reservoirs of water coolers was also observed (see Picture 4). These reservoirs are designed to catch excess water during operation and should be emptied/cleaned regularly to prevent microbial and/or bacterial growth.

Other Concerns

Several conditions that can potentially affect indoor air quality were also identified. Accumulated dust was noted on air diffusers and on flat surfaces throughout the DOR space (see Picture 5). Dust can be irritating to the eyes, nose and respiratory

tract. The large amount of items stored provides a means for dusts, dirt and other potential respiratory irritants to accumulate (see Pictures 6 & 7). These stored items, (e.g., papers, folders, boxes, etc.) make it difficult for custodial staff to clean. Of particular note are items hanging from ceiling tiles.

Lastly, DOR staff frequently use VOC-containing cleaning materials (see Picture 7) to clean their personal work areas. This material contains several VOCs (e.g., isopropyl alcohol and monoethanolamine) that can be irritating to the eyes, nose and throat (3M, 2000). These conditions, in combination with those discussed earlier (e.g., cleaning during work hours, accumulated items) if considered individually present conditions that could degrade indoor air quality. When combined, these conditions can serve to exacerbate conditions leading to eye irritations and other indoor air quality comfort complaints.

Conclusions/Recommendations

Building management and maintenance staff, working in conjunction with DOR personnel have improved indoor air quality conditions in the building by implementing many of the BEHA's previous recommendations. In view of the findings at the time of this visit, the following additional recommendations are made to further improve indoor air quality:

1. Continue working with building management and their HVAC consultant in further improving areas of ventilation/temperature complaints.

2. Replace any remaining water-stained ceiling tiles or other water damaged building materials. Examine above and around these areas for microbial growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.

3. Avoid over watering of plants. Ensure flat surfaces around plants are free of potting soil and other plant debris. Consider reducing the number of plants in some areas. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.

4. Relocate or place tile or rubber matting underneath water coolers and refrigerators in carpeted areas.

5. Continue to implement improved dust control methods such as wet wiping and HEPA vacuuming. Due to security measures and time constraints, a coordinated effort between, DOR management, DOR staff, building management and maintenance personnel should be made to conduct cleaning of offices, common areas and cubicles/personnel work spaces to prevent the accumulation of settled dust.

6. Discontinue the use of VOC-containing cleaners and air fresheners. Less irritating materials, (soap and water) may suffice to clean in these areas.

7. Clean supply and return diffusers periodically of accumulated dust.

8. Refrain from hanging objects from ceiling tile system.

References

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

MDPH. 2000. Indoor Air Quality Assessment, CSE Boston Office, 239 Causeway Street Boston, MA. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA. November 2000.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

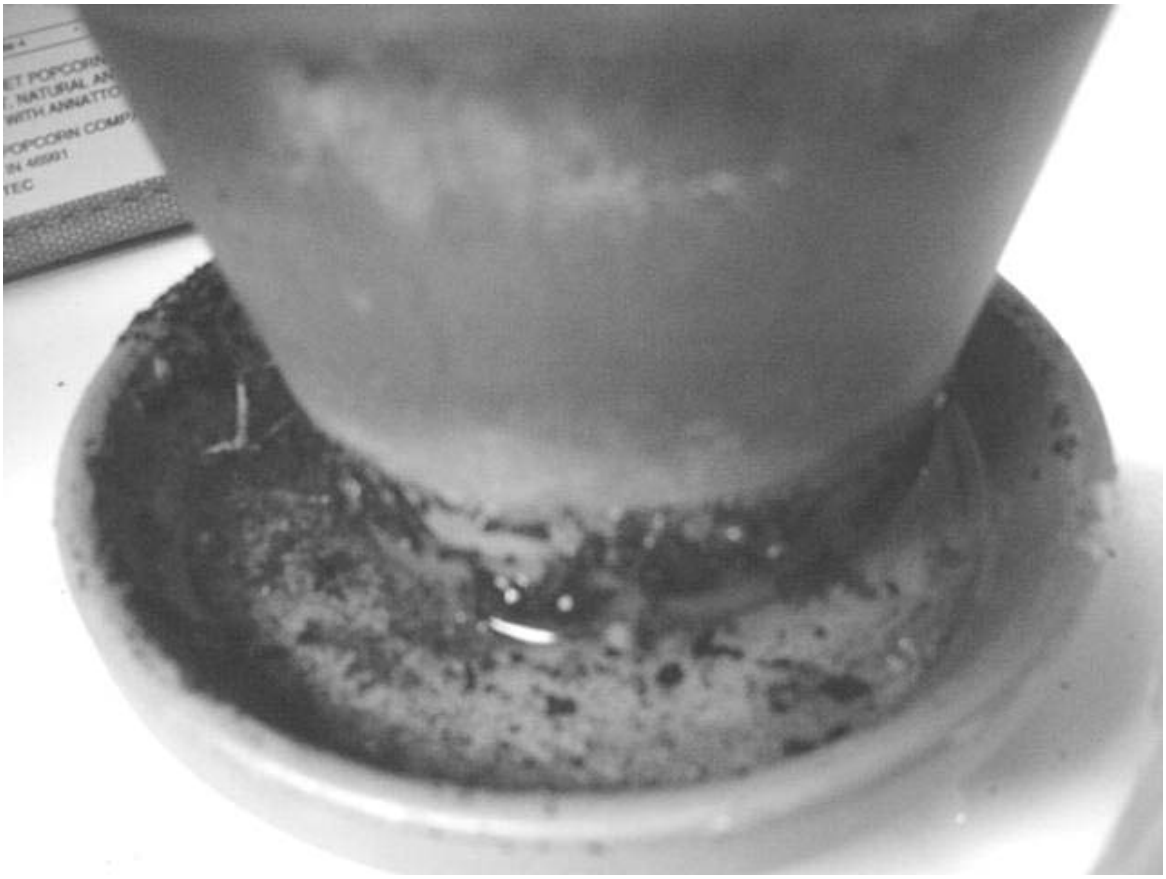
SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

3M 2000. Material Safety Data Sheet (MSDS Document No: 10-0157-7). 3M Brand Desk and Office Cleaner 573. Minnesota Mining and Manufacturing Company. St. Paul, Minnesota.

Picture 1

Potting Soil on Flat Surfaces around Plant

Picture 2



Plant in Standing Water

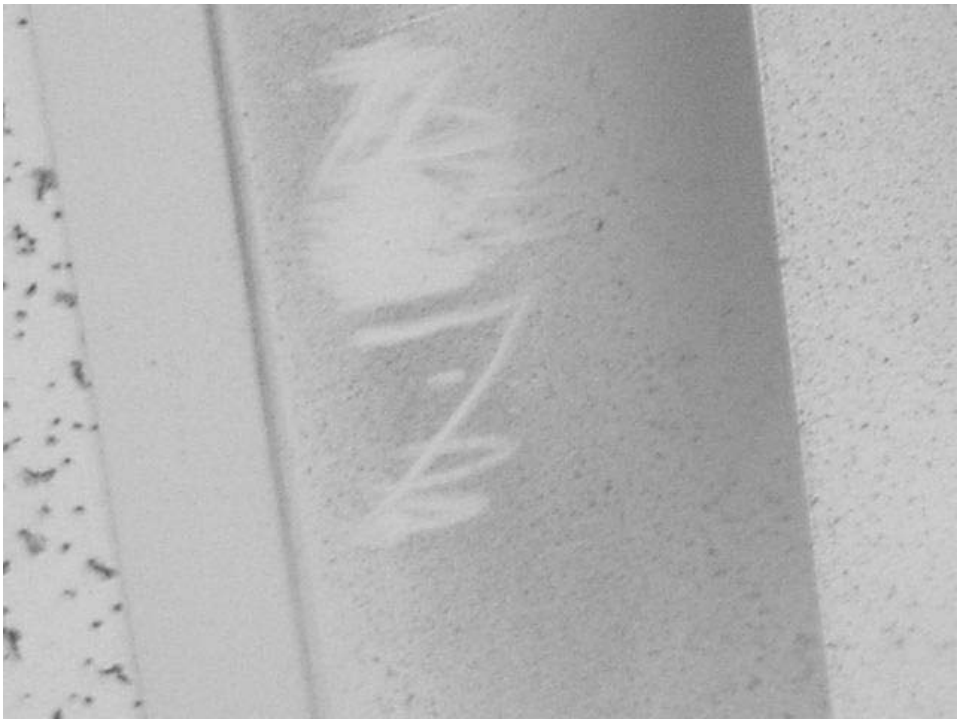
Picture 3

Water Damaged Ceiling Tiles in Area 379

Picture 4

Black Residue/Possible Mold Growth in Water Cooler Catch Basin

Picture 5



Accumulated Dust on Flat Surface

Picture 6

Accumulated Materials and Items Hanging From Ceiling Tile System

Picture 7

VOC-Containing Cleaning Material Used by DOR/CSE Employees

TABLE 1

Indoor Air Test Results –Boston Department of Revenue Offices, 239 Causeway Street, Boston, MA
April 19, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
							Intake	Exhaust	
Outside (Background)	685	3-5	67	47					Causeway Street-heavy traffic
Scanlan Office	892	0	70	43	3	Yes	Yes	No	Office cleaner, door open
Crossman	794	0	70	41	1	Yes	Yes	Yes	Accumulated items
313	840	0-1	70	43	1	No	Yes	Yes	
384 (File Room)	780	0	69	42	4	No	Yes	Yes	Dirt/dust accumulation, stacks of files
327	840	0	72	43	1	No	Yes	Yes	Dead flowers/plant matter
332	832	1-2	72	42	1	Yes	Yes	Yes	Soil on windowsill, water stains, plant in standing water
335	810	2	72	40	0	Yes	Yes	Yes	Water fountain on carpet, refrigerator, debris in /around water cooler
339	812	0-1	72	39	1	Yes	Yes	Yes	

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results –Boston Department of Revenue Offices, 239 Causeway Street, Boston, MA
April 19, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
							Intake	Exhaust	
315	806	2	72	42	2	No	Yes	Yes	Plants
324-Reception	809	1-2	73	42	3	No	Yes	Yes	Complaints of stuffiness, laser printer-heat/odors
388-Copy Room	815	1-2	73	40	1	No	Yes	Yes	Irritating cleaning product, dust/dirt accumulation on supply vents
306	841	0-2	72	38	1	Yes	Yes	Yes	Thermostat fan “on”
308	933	1-2	71	39	3	Yes	Yes	Yes	Door open
311	856	0-2	71	39	1	Yes	Yes	Yes	Door open
380	881	2	72	40	0	Yes	Yes	Yes	Door open, plants
382	895	2	72	40	1	Yes	Yes	Yes	Door open
352	895	2	73	40	5	No	Yes	Yes	Center of aisle

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 3

Indoor Air Test Results –Boston Department of Revenue Offices, 239 Causeway Street, Boston, MA
April 19, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
							Intake	Exhaust	
350	886	2	73	40	4	No	Yes	Yes	
370	887	2	72	40	3	No	Yes	Yes	
374	874	2	73	40	3	No	Yes	Yes	
379	888	2	73	40	4	Yes	Yes	Yes	Water-damaged CT near support beam
Hallway Outside Women's Restroom									Water-damaged CT & water stain on wall
200	525	2	72	40	0	Yes	Yes	Yes	
204	520	2	72	40	0	No	Yes	Yes	
201	523	2	72	39	0	Yes	Yes	Yes	
202	510	2	72	39	0	Yes	Yes	Yes	

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Carbon Dioxide Air Monitoring Results Comparing September 13, 2000 to Sampling on April 19, 2002 Department of Revenue Offices, 239 Causeway Street, Boston, MA

Remarks	Carbon Dioxide *ppm 9/13/00	Occupants in Room	Carbon Dioxide *ppm 4/19/02	Occupants in Room	Change after Renovations (+/-) *ppm	Comments
Outside (Background)	526		685			
201 Training room	730	11	523	0	-207	11 less occupants
Office 311	987	0	856	1	-131	1 more occupant
202	752	0	510	0	-242	
204 – Lounge	745	0	520	0	-225	
200	796	0	525	0	-271	
Cubicle area 379	1064	2	888	4	-176	2 more occupants
384-Central files	937	0	780	4	-157	4 more occupants
Cubicle area 326/327	1322	3	840	1	-482	2 less occupants

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 5

Carbon Dioxide Air Monitoring Results Comparing September 13, 2000 to Sampling on April 19, 2002 Department of Revenue Offices, 239 Causeway Street, Boston, MA

Remarks	Carbon Dioxide *ppm 9/13/00	Occupants in Room	Carbon Dioxide *ppm 4/19/02	Occupants in Room	Change after Renovations (+/-) *ppm	Comments
Cubicle area 331/332	1012	2	832	1	-180	1 less occupant
Cubicle area 310/316/315	1178	1	806	2	-372	1 more occupant
Office 305/306	1063	1	841	1	-222	
Office 382	1044	1	895	1	-149	
Reception Area	984	2	809	3	-175	1 more occupant
Cubicle area 312/313	1026	2	840	1	-186	1 less occupant
*Cubicle area 384	854	0	780	4	-74	4 more occupants

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Appendix I

The following is a status report of action(s) taken on previous BEHA recommendations (**in bold**) based on reports from building staff, documents, photographs and BEHA staff observations.

1. **Continue to work with building management to develop a preventative maintenance program for all HVAC equipment.**

   Action Taken: A preventative maintenance plan has been developed for all HVAC equipment. DOR has hired Preventive Maintenance Corporation (PMC), an HVAC contractor.

2. **Change filters for AHU equipment as per the manufacturer's instructions or more frequently if needed. Examine rooftop HVAC equipment and heat pumps periodically for maintenance and function.**

   Action Taken: Filters are reportedly changed by PMC four times per year. Filters for the rooftop AHU are changed upon need, (usually weekly).

3. **Consider increasing the dust-spot efficiency of HVAC filters. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer as to whether it can maintain function with more efficient filters.**

   Action Taken: Filters presently in use have been upgraded to 90 percent efficiency.

4. **To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of building occupancy**

independent of thermostat control. Consider setting thermostat controls to the "on" position to provide constant supply and exhaust ventilation.

Action Taken: Thermostats are now set to the fan "on" position providing constant airflow.

5. **In order to improve indoor air quality, an increase in the percentage of fresh air supply into the HVAC system may be necessary for some areas.**

   Action Taken: No information was provided concerning this recommendation. DOR personnel should continue to work with their HVAC contractor to identify areas of ventilation/comfort complaints.

6. **Consider having the ventilation system balanced by an HVAC engineer.**

   Action Taken: The HVAC system was reportedly balanced by PMC.

7. **Remove blockages from air diffusers (i.e. cardboard) to facilitate airflow.**

   Action Taken: Obstructions were removed from air diffusers.

8. **Report any roof leaks or other signs of water penetration to the building manager for prompt remediation.**

   Action Taken: No signs of further water damage were reported, however water damaged ceiling tiles were observed in a few areas.

9. **Ensure all plants are equipped with drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Consider discontinuing the use of hanging plants over carpeted areas.**

Action Taken: Hanging plants continue to exist in office space. For more information regarding the conditions of plants during this reassessment see **Moisture/Microbial Concerns** section of this report.

10. **Replace plastic tubing connecting the condensation drains to the cooling units. Examine flexible hosing for mold growth during routine changing of filters. Replace or disinfect this tubing with an appropriate antimicrobial prior to the air-conditioning season on a routine basis.**

Action Taken: Heat pumps and associated components were reportedly cleaned and treated for microbial growth by PMC.

11. **For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).**

Action Taken: HEPA filtered vacuum cleaners are used on carpets, which has helped reduce levels of airborne dust. However, due to security reasons general cleaning of the space is conducted during the day while occupied by employees. Potential indoor air quality issues concerning this is addressed in the **Other Concerns** section of the reassessment. DOR officials reported that conducting a thorough cleaning would be difficult due to the prevalence

of both business and personal items stored throughout the DOR/CSE offices.

12. **Consider consulting a ventilation engineer concerning the improvement of mechanical exhaust ventilation in the copy room or move equipment to a well-ventilated area.**

    Action Taken: No action was taken regarding this recommendation.

13. **Ensure water is poured into floor drains regularly to maintain the integrity of the traps.**

    Action Taken: Water is reportedly poured down drains to maintain the integrity of traps.

14. **Prohibit smoking in the building or limit smoking to a designated smoking area equipped with ventilation as prescribed by ASHRAE. If this is not feasible, seal utility holes and any spaces in floor decking to eliminate pollutant paths of migration. Consider installing a drop ceiling to serve as a barrier to help prevent smoke migration.**

    Action Taken: No further complaints of smoke odors or evidence of smoking were reported during the reassessment.

15. **Use IPM to remove pests from the building.**

    Action Taken: DOR officials reported that due to the prevalence of cluttered items throughout the DOR space, it would be difficult to eliminate harborages for pests. It was also recommended by DOR officials that kitchen appliances be regularly cleaned to eliminate the attraction of pests